AD-A144 218 OPERATIONAL REQUIREMENTS FOR THE REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)(U) FEDERAL AVIATION ADMINISTRATION WASHINGTON DC JUN 84 FAA-NAS-MD-792 1/1

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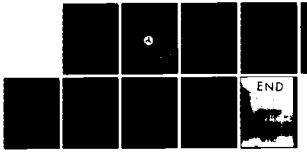

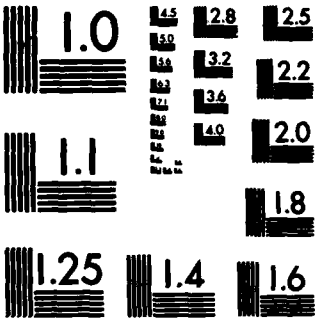

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NATIONAL AIRSPACE SYSTEM CONFIGURATION MANAGEMENT DOCUMENT

NAS-MD-792

OPERATIONAL REQUIREMENTS FOR THE REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)

JUNE 1984

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

OPERATIONAL REQUIREMENTS FOR THE
REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)

TABLE OF CONTENTS

Chapter One: INTRODUCTION

1.1 Purpose
1.2 Background
1.3 Assumptions and Constraints

Chapter Two: RMMS OPERATIONAL REQUIREMENTS

2.0 Introduction
2.1 Facilities Monitor and Alarm
2.1.1 Alarm Processing
2.1.2 Alarm Types
2.1.3 Automatic Alarm Notification
2.2 Certification
2.3 Remote Control
2.4 Record Keeping
2.5 Trend Analysis
2.6 Diagnostics
2.7 Adjustment
2.8 Failure Anticipation
2.9 Problem-Solutions File
2.10 System Security
2.10.1 Physical Access
2.10.2 Data Security Control

Chapter Three: NETWORK CONCEPT

3.0 Network Description
3.1 Remote Maintenance Monitor System (RMMS)
3.1.1 Maintenance Processor Subsystem (MPS)
3.1.2 Remote Monitor Subsystem Concentrator (RMSC)
3.1.3 Remote Monitoring Subsystem (RMS)
3.1.4 Sensor Interface (SI)
3.1.5 Regional Office Node
3.2 Terminal System
3.3 National Interfacility Communications System (NICS)
3.4 Maintenance Management System (MMS)

Chapter Four: NETWORK SUPPORT REQUIREMENTS

4.0 Introduction
4.1 Transition
4.2 Training
4.3 Documentation
4.3.1 Operator Manuals
4.3.2 Maintenance Manuals

CHAPTER ONE
INTRODUCTION

This operational requirements document was prepared for use in support of the development and implementation of a Remote Maintenance Monitoring System (RMMS) for the National Airspace System (NAS). Fundamental concepts of RMMS operation and the system description have been previously developed by the Airway Facilities Service (AAF). These concepts are documented in the Maintenance Philosophy Steering Group (MPSG) Report (Order 6000.27), the Airway Facilities Service Maintenance Program (Order 6000.10), and the Airway Facilities Service Policy Decisions for the Maintenance Program of the 1980's (Order 6000.30).

The information generated by the Remote Monitoring Subsystem (RMS) at the equipment site shall be directly available to the responsible maintenance personnel at their work center. Initially, a Maintenance Processor Subsystem (MPS) will be installed at the ARTCC where communications lines with enroute equipment and major airports presently exist. Future MPSs shall be located at sector offices, or major workcenters. The MPS shall monitor the status of all equipment for a specific geographical area and shall automatically notify the monitoring facilities of the equipment alarms. The monitoring facility shall be alerted of an alarm by both visual and aural signals describing where alarm has occurred, the type of alarm, and which equipment is alarming. The MPS shall serve as the primary collection point, processor, and distribution center for all RMM and Maintenance Management System (MMS) data. The RMMS will remote many routine maintenance functions currently performed at the remote equipment sites and will permit them to be accomplished at any suitably equipped work center.

1.1 PURPOSE.

It is the purpose of this document to specify the operational requirements of the RMMS and to assure that the requirements of the AF systems specialist are reflected in its implementation.

1.2 BACKGROUND.

As a result of the FAA's examination of its future maintenance workload, the concept of remote maintenance monitoring has been developed. This concept is tailored to take advantage of the electronic sophistication and inherently increased reliability of new-generation equipment for the National Airspace System. The introduction of solid-state equipment has improved the stability of new equipment and reduced the number of site equipment failures, in turn reducing the need for technicians to travel to sites for frequent periodic maintenance and failure correction. In addition, the capability to monitor remote-site paramenters at centralized facilities will simplify certification.

1.3 ASSUMPTIONS AND CONSTRAINTS.

Order 6000.27A establishes assumptions and constraints for the 80's maintenance concept. Those affecting RMMS are as follows:

The assumptions are:

- o Today's technician will become a systems specialist and continue as the primary and most important member of the maintenance system.
- o Pressures to control the overall costs will continue. With additional facilities containing more complex equipments in the inventory, a program of increased maintenance efficiency is required. Without such a program, the size of the maintenance workforce would continue to grow.
- o Increased activity levels and dependence by the air traffic controllers on the equipments will dictate reliability levels in excess of those now being achieved.
- o To keep operation costs at a stable level, additional communications lines for RMM data will be provided through the National Interfacility Communications System (NICS).

The constraints are:

- o The RMM System will be required to operate continuously to ensure that site malfunctions are promptly detected so that proper corrective maintenance can be performed.
- o A failure of the RMM equipment shall not cause loss of service to the aviation user.
- o The future organization will be smaller in size.
- o The existing NAS system must continue to operate until a replacement system is installed and accepted. These existing systems must be maintained at the current high reliability and availability levels.
- o Existing documentation has detailed some design features of the RMMS. These design features must be adhered to or changed through appropriate channels.
- o Attitudes toward changes could effect the implementation of remote monitoring. Personal concerns over the quality of worklife associated with changes in work methods could have a negative impact on timely implementation. These changes and their positive or negative impacts must be understood by the work force. With proper attention to the specialist's concerns, impact to the workforce can be minimized.

CHAPTER TWO
RMMS OPERATIONAL REQUIREMENTS

2.0 INTRODUCTION.

The purpose of this chapter is to describe operational requirements that the RMMS must provide to personnel in the various operations, maintenance, and support groups associated with the RMMS. Airway Facilities equipment will be remotely monitored, when cost effective.

There are ten RMMS capabilities that are required to meet service goals. These capabilities are:

1. Monitor and Alarm
2. Certification
3. Remote Control
4. Recordkeeping
5. Trend Analysis
6 Diagnostics
7. Adjustment
8. Failure Anticipation
9. Problem-Solutions File
10. System Security

2.1 MONITOR AND ALARM.

The RMMS shall continuously monitor all critical parameters to determine if the equipment is operating within specified units. Parameter values shall be compared with known values or operational limits, and any deviations from tolerance values shall be flagged as alarms. All alarms detected shall be recorded. If an alarm is detected, the Maintenance Processing Subsystem (MPS) shall immediately notify the Airway Facility organizational element having monitoring responsibility for the facility. In addition, air traffic control (ATC) personnel who might be impacted by a failure shall be provided with the operational status of the equipment. The MPS shall periodically poll all the facility RMSs under its control to obtain the data required for determination of status. Two levels of information, as described below, shall be available at the MPS facility for normal operations processing. Depending on the complexity of the site equipment monitored, the MPS facility shall use at least one of these to determine normal operations:

Performance Test Results. To certify equipment, dynamic performance tests must be conducted since passive monitoring of parametric data will not provide a high degree of confidence in equipment operation.

Parameteric Alarms. These shall be generated by the remote monitor subsystem when a given sensor measurement exceeds its prescribed tolerance limits.

2.1.1 ALARM PROCESSING.

The reporting of alarm conditions, indicating that an undesired event has occured, is of paramount importance to ensure immediate maintenance response and improved system operation. The MPS shall distinguish between the origins of equipment alarms and provide appropriate data to the monitoring facility responsible for the affected equipment. The location of the monitoring facility/location will be dictated by operational needs.

2.1.2 ALARM TYPES.

The RMMS shall have the capability of distinguishing between three levels of alarms: operational system failure alarms; pre-alarms; and security alarms. These different levels provide the systems specialist with the information required to distinguish between time-critical and nontime-critical alarms. These alarms are as follows:

- o Operational Equipment Failure Alarms. These alarms indicate that equipment failure has occured in the system; they require immediate notification of the monitoring facility. Even the failure of a system with redundant elements shall be included in this category. Although the facility may continue in operation immediate attention may be required.

- o Pre-Alarms. These alarms indicate that an equipment may fail and the system may require immediate attention. This category includes pre-alarms indicating that conditions at the site are approaching failure but no equipment outage has occurred.

- o Security Alarms. These alarms indicate that physical intrusion into a facility has occurred, smoke or fire are detected, or an unauthorized request for MPS data has been received.

2.1.3 AUTOMATIC ALARM NOTIFICATION.

A specific indication at the monitoring facility terminal shall distinguish between an operational alarm, pre-alarm, or security alarm. Operational alarms that render the system unavailable for service will automatically be sent to the appropriate air traffic facility.

2.2 CERTIFICATION.

At preselected intervals, and as determined by maintenance or certifying personnel, the MPS shall query the remote sites and the values of the parameters shall be recorded. The MPS facility will acquire and store the information collected by the RMMS from the individual sites and process that information into usable form for the personnel requiring access to it. All site data shall be accumulated on a periodic basis. All alarms, and site data shall be collected and maintained on a time-date basis as historical files.

2.3 REMOTE CONTROL.

This capability allows initial facility restoration actions from a remote location. The facility may be powered up or down, switched from main to standby, etc., remotely. The RMS will have the capability to interpret messages containing equipment control information. Examples of this capability are switching equipment from main to standby, turning the engine generator and air conditioner on and off, etc. In addition, the RMS will have the ability to attempt reset of a facility before a failure is declared. The monitoring facility will be notified of these reset attempts.

2.4 RECORD KEEPING.

The system shall record all pertinent information at the MPS and shall provide for retrieval of this data by the AF technical workforce via terminals. All information sent to the MPS shall be retreivable on a site-by-site basis. The ability to designate selected portions of the historical file for a given site or group of sites will be provided. The MPS shall output pertinent reduced data upon operator request.

2.5 TREND ANALYSIS.

The MPS shall record pertinent information identified for each device and maintain a file of this information. On demand, the MPS shall analyze the stored information and display performance trends. Graphs or tabular data will be used to present the results. Upon operator request the MPS shall automatically generate peroidic performance reports that are now manually prepared. If a user requires an immediate report, it can be requested from the MPS. For example, the MPS may generate graphs of parameter variations with time; specific failures by type, reason for failure and corrective action; reliability and availability history; outage reports; equipment failure and alarm reports, etc.

2.6 DIAGNOSTICS.

The remote facility equipment will provide diagnostic and fault information to assist the specialist to identify the failing component or module where possible prior to the specialist leaving for the site. This will enable the specialist to analyze the problem and to take the necessary replacement parts and test equipment to the site. A number of systems now exist which will be retained for some time and must be incorporated into the RMMS. Where cost effective, these systems will be retrofitted with remote diagnostics and fault isolation capability. In new systems, this capability shall be embedded.

The RMMS shall have the capability to provide the appropriate hardware, software, and control signals to adjust the operational equipment and perform diagnostic tests. Further enhancements to the diagnostic process, such as the display of schematics, assembly/disassembly information, complex pictorial data, and waveforms at the system specialist's terminal, may be implemented if economically feasible.

2.7 ADJUSTMENT.

This capability will permit adjustment of the equipment from a remote location. Two types of control messages will be generated by the MPS for transmission over the RMMS telecommunications network: execution of diagnostics and remote equipment adjustment. The MPS will generate the appropriate messages to initiate these tests at the remote site and measure responses.

2.8 FAILURE ANTICIPATION.

Based upon the sensed parameters and known failure conditions, the MPS will predict, where possible, which items of equipment are likely to fail and which component(s) of the equipment should be replaced. This will permit automatic or manual preemptive actions to prevent equipment failures.

2.9 PROBLEM-SOLUTIONS FILE.

This capability will provide the systems specialist with case histories of past problems and their solutions. The MPS will maintain a case-history file of reported troubles and solutions for a given maintenance area. This file will be in the MPS main storage and readily available to any systems specialist in that area. Perodically this data will be transferred to a mass storage media for transfer to a centralized national computer file, where data will be kept for all maintenance areas within the FAA. This is compiled from the automated logkeeping records.

2.10 SYSTEM SECURITY.

There are three types of security and access-control functions of the MPS:

1. restriction of physical access to RMMS and operational equipment,
2. access to MPS data and control functions employing an on-line terminal. The following subsections outline the proposed security measures for each type, and
3. detection of smoke or fire within the facility.

2.10.1 PHYSICAL ACCESS.

The RMS shall have an intrusion alarm monitor attached to the entrance of the facility. All entries to the facility shall trigger the RMS to send a notice of intrusion to the monitoring facility. All authorized personnel are expected to log in on the terminal within a reasonable period of time. Failure to do so shall result in the annunciation of an intrusion alarm by the MPS.

2.10.2 DATA SECURITY CONTROL.

Data security control shall be provided by the RMMS. Specifically, the software shall ensure security by permitting the following:

- o Data access only in response to valid log-in procedures.
- o Access to data as necessitated by the maintenance/repair specified.
- o Control function capability only to authorized persons.
  Certification of facilities only by authorized persons.

The processor's authorization profile of maintenance personnel shall be established through the log-in procedure. After the facility is entered, the systems specialist must enter a specifically assigned access code within the time period allowed. The access code shall be checked by the MPS for validity. Whenever an individual's responsibility for a maintenance area has been changed, that individual's files in the RMMS shall be changed.

2.10.2.1 AUTO-DIAL INTERFACES.

All telephone auto-dial feature interface with the RMMS shall be at the Remote Monitor Subsystem Concentrator (RMSC) level and above. Except where special communications restrictions are a problem, all security for auto-dial access to the RMMS shall be controlled by the MPS. Approval to allow security control below the MPS level must be coordinated through the NAS Change Proposal (NCP) process.

CHAPTER THREE
NETWORK CONCEPT

3.0 NETWORK DESCRIPTION.

The network will consist of four elements. These four elements are:

1. Remote Maintenance Monitoring System (RMMS).
2. Data Terminals (both fixed and portable).
3. National Interfacility Communications System (NICS).
4. The Maintenance Management System (MMS) will coexist with the RMMS and share resources.

Figure 3.1 is an overall block diagram of the network. The network will consist of equipment to perform facility monitoring, data acquisition and alarm reporting functions. The MPS will act as a node of the network to collect, record, and analyze facility data, and to distribute it to appropriate locations. Terminals will be used by systems specialists to obtain immediate status information at a facility directly or information on a remote facility via the MPS.

Modular design of both hardware and software will ensure expandability to increase capacity with minimum modifications. The use of software techniques will provide flexibility in adding and changing the system to receive or delete equipment systems.

To miminize the risk of failure at remote facilities, the RMS shall be designed for simplicity. Any complexity should be at the workcenter level and above.

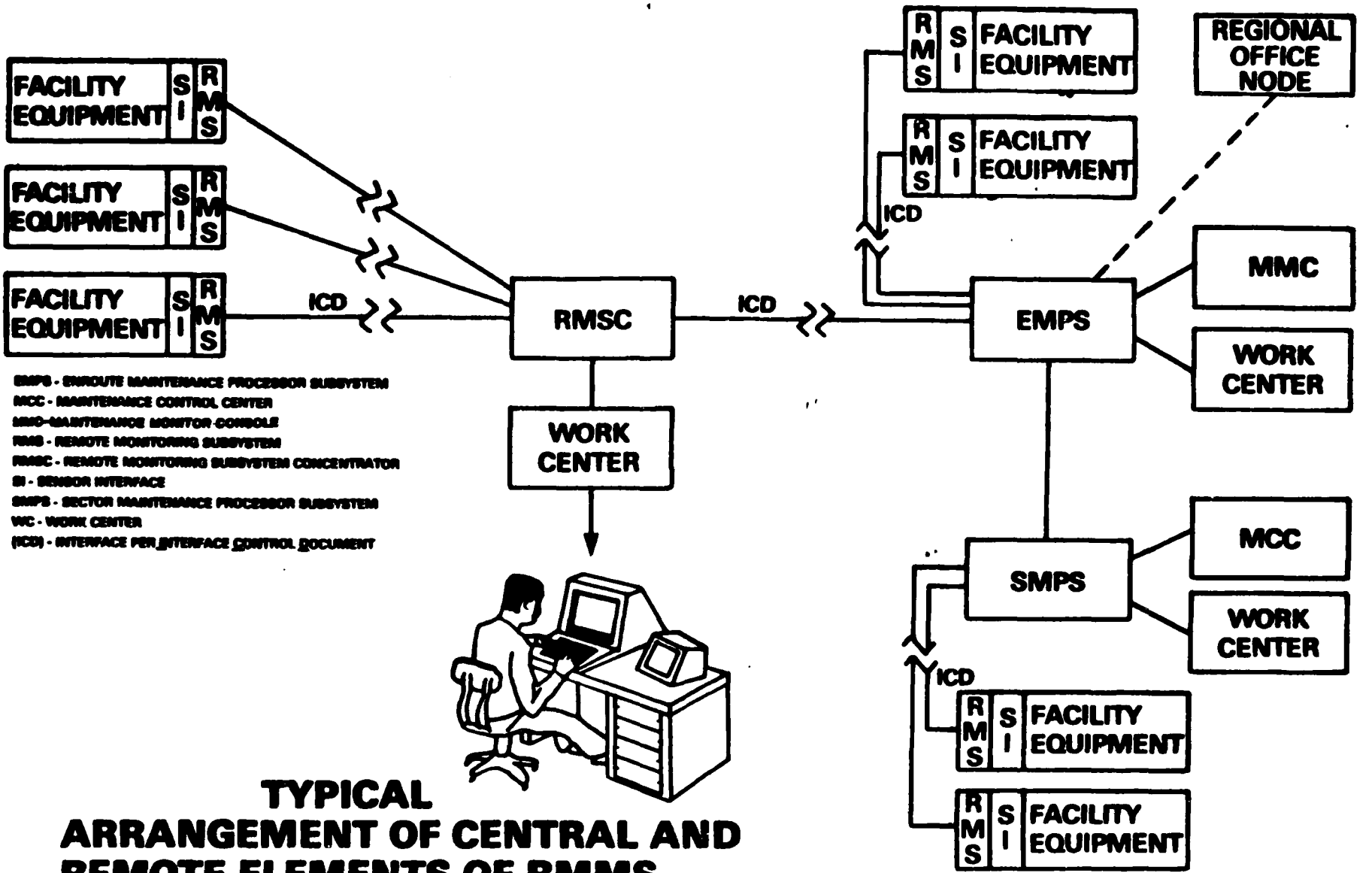
3.1 REMOTE MAINTENANCE MONITOR SYSTEM (RMMS).

The RMMS will serve as a data collecting and control system. Systems located within an ARTCC facility will have an Operations and Service Processor (OSP) to provide diagnostic and maintenance capabilities to the systems specialists. These systems will also provide status data to the enroute MPS by a simple RMS interface. This status data is required for system monitoring and reporting requirements.

Several RMMS elements shall interface those systems remote from an ARTCC facility. They will consist of the remote monitoring subsystem concentrator, remote monitoring subsystem, and sensor interface. A description of these three elements follows.

3.1.1 MAINTENANCE PROCESSOR SUBSYSTEM (MPS).

The MPS will serve as the central processor for a given geographical area and will act as a control point to collect, record and analyze monitored data and to issue commands. The MPS will also be responsible for the display of monitored data and the maintenance of a historical record of reported data. The MPS will receive periodic status and certification reports from the RMSs upon occurrence. Two types of MPS are proposed, En Route Maintenance Processor Subsystem (EMPS), and Sector Maintenance Processor Subsystem (SMPS). Additional MPSs will be provided at the National Field Support Sectors, FAA Technical Center, and Washington headquarters.



TYPICAL ARRANGEMENT OF CENTRAL AND REMOTE ELEMENTS OF RMMS

Figure 3-1

3.1.2 REMOTE MONITOR SUBSYSTEM PROCESSOR CONCENTRATOR (RMSC).

At locations where there is a concentration of RMM equipped facilities, such as an airport, considerable reduction of operations costs and alarm response time can be realized if all facilities data are combined into a single interface to the MPS. The function of the RMSC is to perform this task of consolidating data from all the facilities within a small geographical area and interface these facilities to the MPS. The RMSC will function as a point of interface to the RMMS for providing facility status information to Air Traffic operations at terminal facilities. The RMSC will also provide an alternate point of control when the MPS or interconnecting ICS is not available. All auto-dial interfaces shall be at the RMSC level and above.

3.1.3 REMOTE MONITORING SUBSYSTEM (RMS).

The RMS will consist of monitoring subsystems, data acquisition subsystems, and controller devices to perform monitoring, data gathering, and alarm determination functions for the various equipment associated with the facilities. The RMS will have the capability to sample equipment monitors and sensors, accept and process MPS commands, generate and transmit formatted data messages to the MPS and provide a buffer for the on-line terminal interface.

3.1.4 SENSOR INTERFACE (SI).

The sensor interface is the actual point of tie-in to the facility equipment. The SI will be equipment unique for the specific function/parameter to be controlled or monitored. These devices will be built into future equipment. Existing equipment will require a retrofit modification.

3.1.5 REGIONAL OFFICE NODE.

The regional office node will function in a manner yet to be determined.

3.2 TERMINAL SYSTEM.

Two types of terminal access will be included in RMMS:

Fixed terminals will be located at work stations and work centers (WC) such as sector field offices. Work centers will be notified by the MPS via this terminal output of alarm conditions and status changes. Conversely the systems specialists can query the MPS for certification and status data. The MPS will communicate with these terminals via dedicated lines.

Terminals will be used by systems specialists to extract the current state of equipment performance. These terminals can also communicate with the MPS for additional data via dial-up connections.

The communications systems required to pass data and control instructions to and from the terminal to the MPS or RMS is considered part of the NICS.

3.3 NATIONAL INTERFACILITY COMMUNICATIONS SYSTEM (NICS).

The necessary information transfer between elements of the RMMS and/or terminals will be accomplished through the NICS. A ground rule for NICS development is to minimize, wherever possible, any additional communications circuit costs. Consequently, the NICS will, when feasible, use existing communications facilities. A backup link using automatic dial-up techniques over commercial (switched) telephone lines or other means such as another dedicated line or RML channel will be provided in the event of primary communications link failures.

3.4 MAINTENANCE MANAGEMENT SYSTEM (MMS).

The MMS will be an administrative and technical support system designed to automate the collection, storage, analysis and distribution of data as well as the monitoring of administrative and technical functions. This system will allow various levels in the Airway Facilities hierarchy the capability to input, access and process the information required to administer AF programs efficiently.

Examples of some of the many programs which will be managed with the use of this system are:

- o Facility logs.
- o Equipment performance data.
- o Trouble shooting data.
- o Logistics inventory.
- o Equipment failure analysis.
- o Facilities master file.
- o Administrative records.
- o Energy consumption.

The full capability of the Maintenance Management System will be phased in with the complete deployment and implementation of the Remote Maintenance Monitoring System.

CHAPTER FOUR
NETWORK SUPPORT REQUIREMENTS

4.0 INTRODUCTION

The purpose of the Maintenance Program of the 1980's is to make better use of the maintenance work force through changes in work methods. This will be made possible by using technologies, especially remote maintenance monitoring. If the RMMS is to provide the significant benefits required, today's technician must be provided the additional knowledge, skills and resources demanded by the technologies.

4.1 TRANSITION

The role of the technician must transition into that of a systems specialist. The technician's primary functions are preventive and corrective maintenance of facilities and equipment using hardware oriented, in-depth knowledge and skills. The systems specialist of the new maintenance program era will be both software and hardware oriented and will assume a higher level of decision making with regard to the NAS. The decision making will be based on conceptual knowledge and multi-skills at the the system level.

4.2 TRAINING

Presently, technical training requirements are met by several methods. Included are resident training at the FAA Academy at Oklahoma City, out-of-agency training, correspondence study, Computer Based Instruction and on-the-job training. Of the above methods, the most common is resident training at the FAA Academy. This traditional approach to training has served the FAA well; however, technology must influence future training methods.

Systems specialists must receive software as well as hardware training. This training must be tailored to the types of monitoring/sensor equipment and terminal devices being utilized. Computer Based Instruction (CBI) will become the primary training method with future systems providing system embedded training. To assist the systems specialist in staying proficient, controlled CBI training should be provided at the work center level.

4.3 DOCUMENTATION

Complete documentation and technical literature are required for the operation of all RMMS elements, including:

1. Operator manuals.
2. Maintenance manuals.
3. Hardware logic diagrams.
4. Software listings and flow charts.
5. Software Design Documents
6. Computer Program Functional Specifications

4.3.1 OPERATOR MANUALS

Comprehensive operational manuals must be provided, thereby permitting rapid and efficient information retrieval in response to system malfunctions and maintenance support requirements. These manuals need not present detailed theoretical discussions. Any necessary actions and procedures for remedial maintenance should be included in the manuals.

4.3.2 MAINTENANCE MANUALS

Detailed maintenance manuals shall be prepared. They should contain clear instructions concerning maintenance operations, including diagrams, pictures, and flow charts. In addition, where applicable, the methods for using diagnostic routines to simplify fault isolation and system restoration must be provided for all supplied equipment.

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